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Taguchi

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(54) **IMAGE FORMING APPARATUS, AND METHOD CAPABLE OF COMPOSITING COLOR IMAGES WITH A UNIT THAT COLOR-CONVERTS AND THEN COMPRESSES EACH OF THE PLURALITY OF PIECES OF IMAGE DATA**

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G06K 15/02 (2006.01)

(52) **U.S. Cl.**
CPC ***G06K 15/1851*** (2013.01); ***G06K 15/1856*** (2013.01); ***G06K 15/1861*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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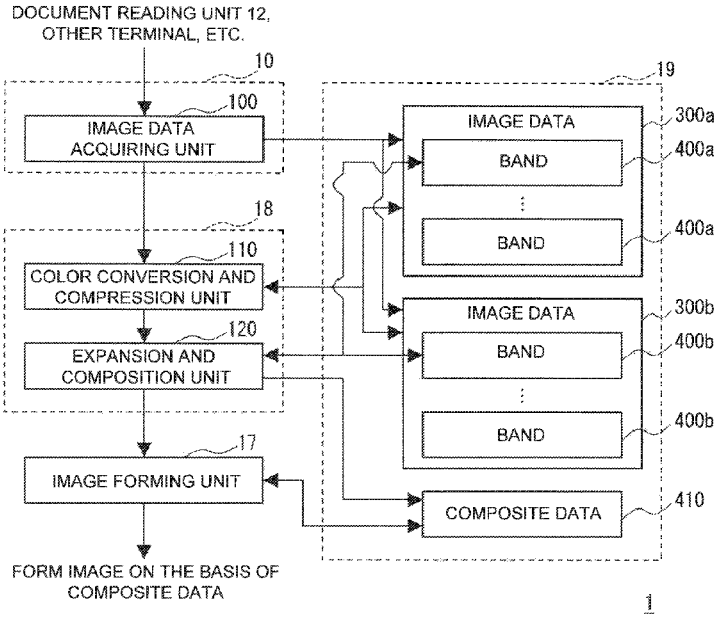
Primary Examiner — Steven Kau

(57) **ABSTRACT**

An image forming apparatus is capable of compositing a plurality of pieces of image data. The image forming apparatus includes a color conversion and compression unit, an expansion and composition unit, and an image forming unit. The color conversion and compression unit color-converts and then compresses each of the plurality of pieces of image data in units of band data, the band data being part of the image data. The expansion and composition unit expands and composites, in units of the band data, the plurality of pieces of image data color-converted and then compressed in units of the band data by the color conversion and compression unit. The image forming unit forms an image on the basis of the band data composited by the expansion and composition unit.

2 Claims, 7 Drawing Sheets



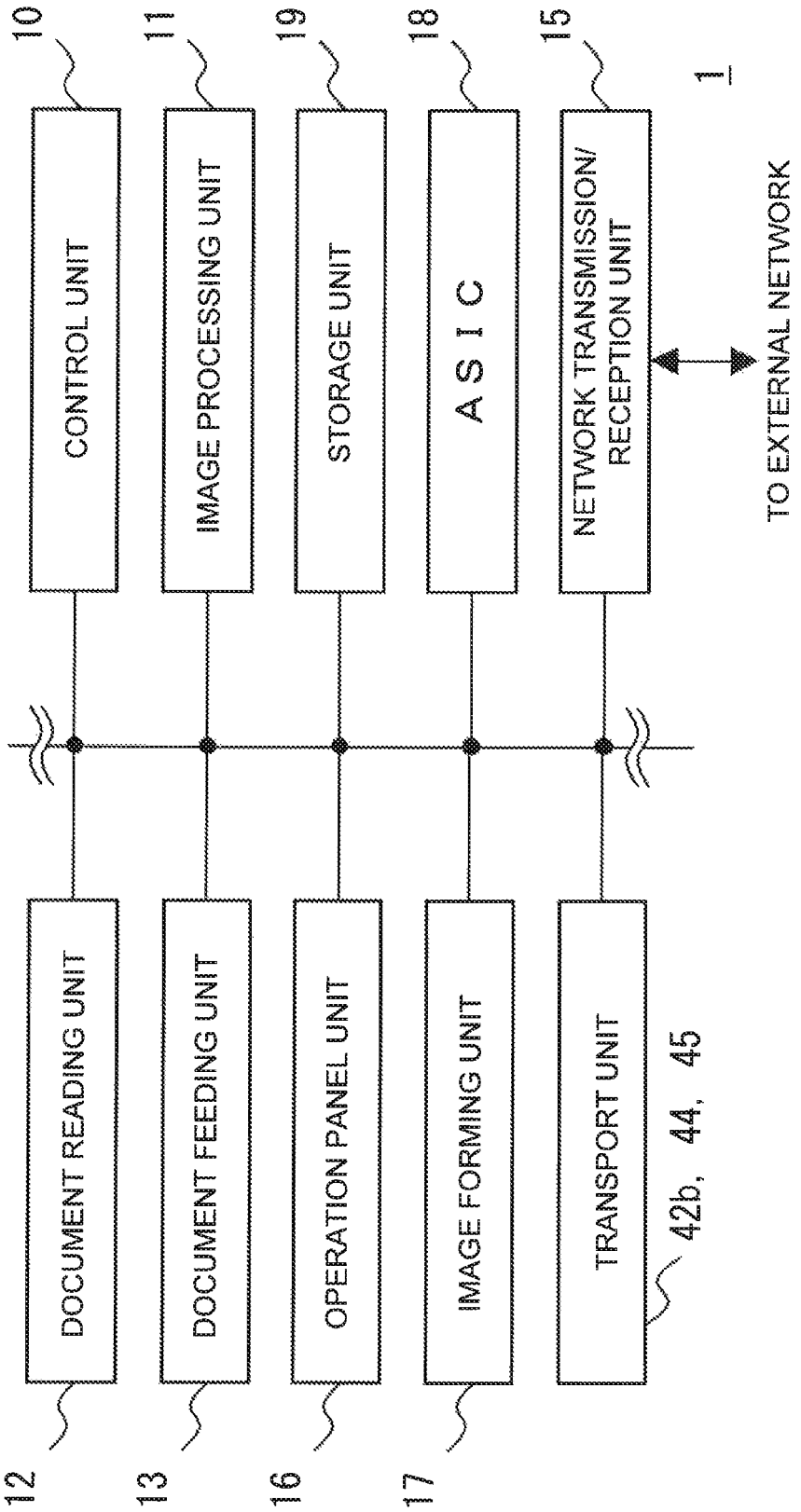

10
CONTROL UNIT
11
IMAGE PROCESSING UNIT
19
STORAGE UNIT
18
ASIC
15
NETWORK TRANSMISSION/ RECEPTION UNIT
1
TO EXTERNAL NETWORK
12
DOCUMENT READING UNIT
13
DOCUMENT FEEDING UNIT
16
OPERATION PANEL UNIT
17
IMAGE FORMING UNIT
TRANSPORT UNIT
42b, 44, 45

FIG.1

FIG.2

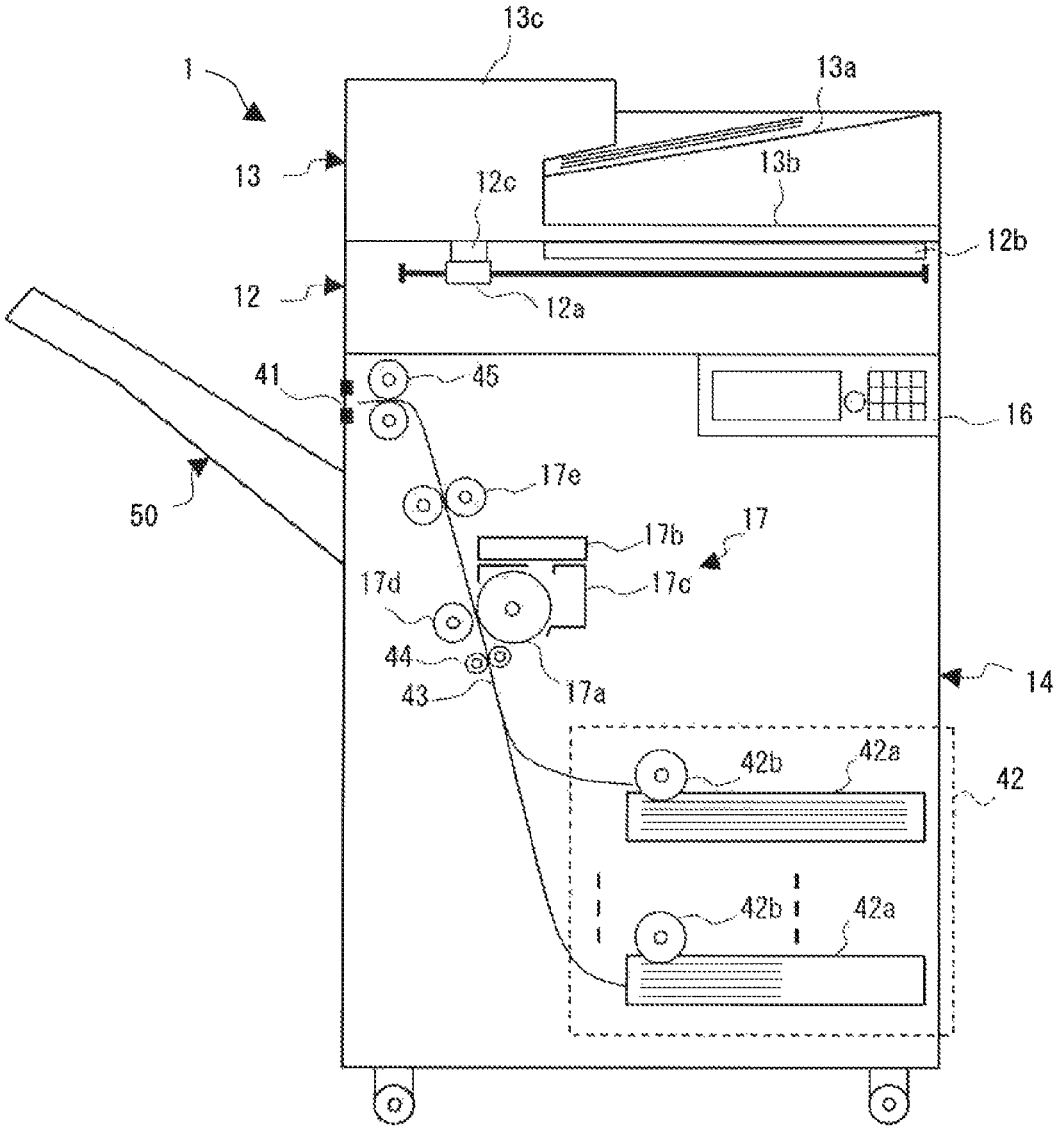

13c
1
13a
13
13b
12c
12b
12
12a
41
45
16
17e
50
17b
17
17d
17c
44
14
43
17a
42b
42a
42
42b
42a

FIG.3

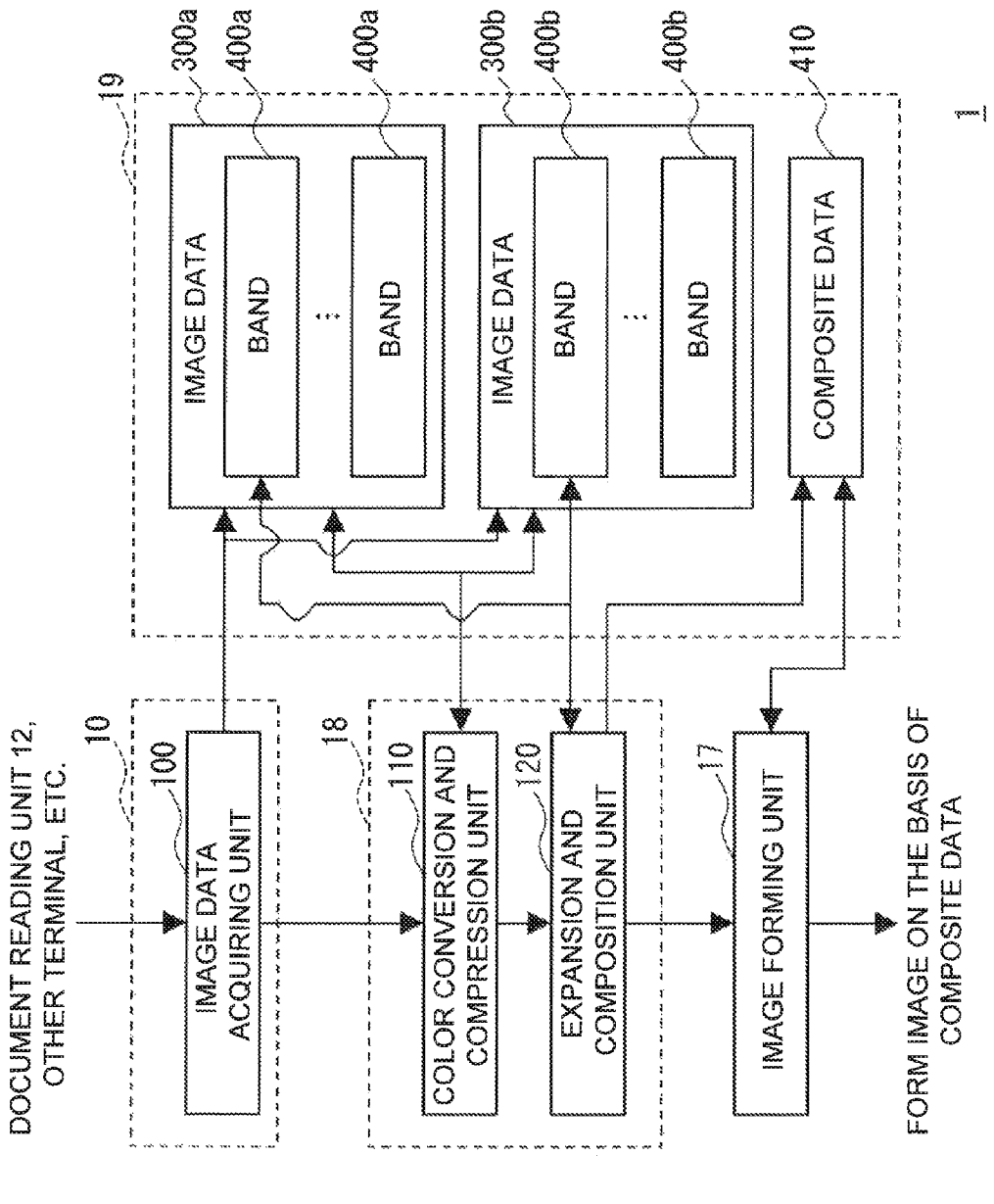

DOCUMENT READING UNIT 12, OTHER TERMINAL, ETC.
10
100
IMAGE DATA ACQUIRING UNIT
18
110
COLOR CONVERSION AND COMPRESSION UNIT
120
EXPANSION AND COMPOSITION UNIT
17
IMAGE FORMING UNIT
FORM IMAGE ON THE BASIS OF COMPOSITE DATA
19
300a
400a
IMAGE DATA
BAND
BAND
400a
300b
400b
IMAGE DATA
BAND
BAND
400b
410
COMPOSITE DATA
1

FIG.4

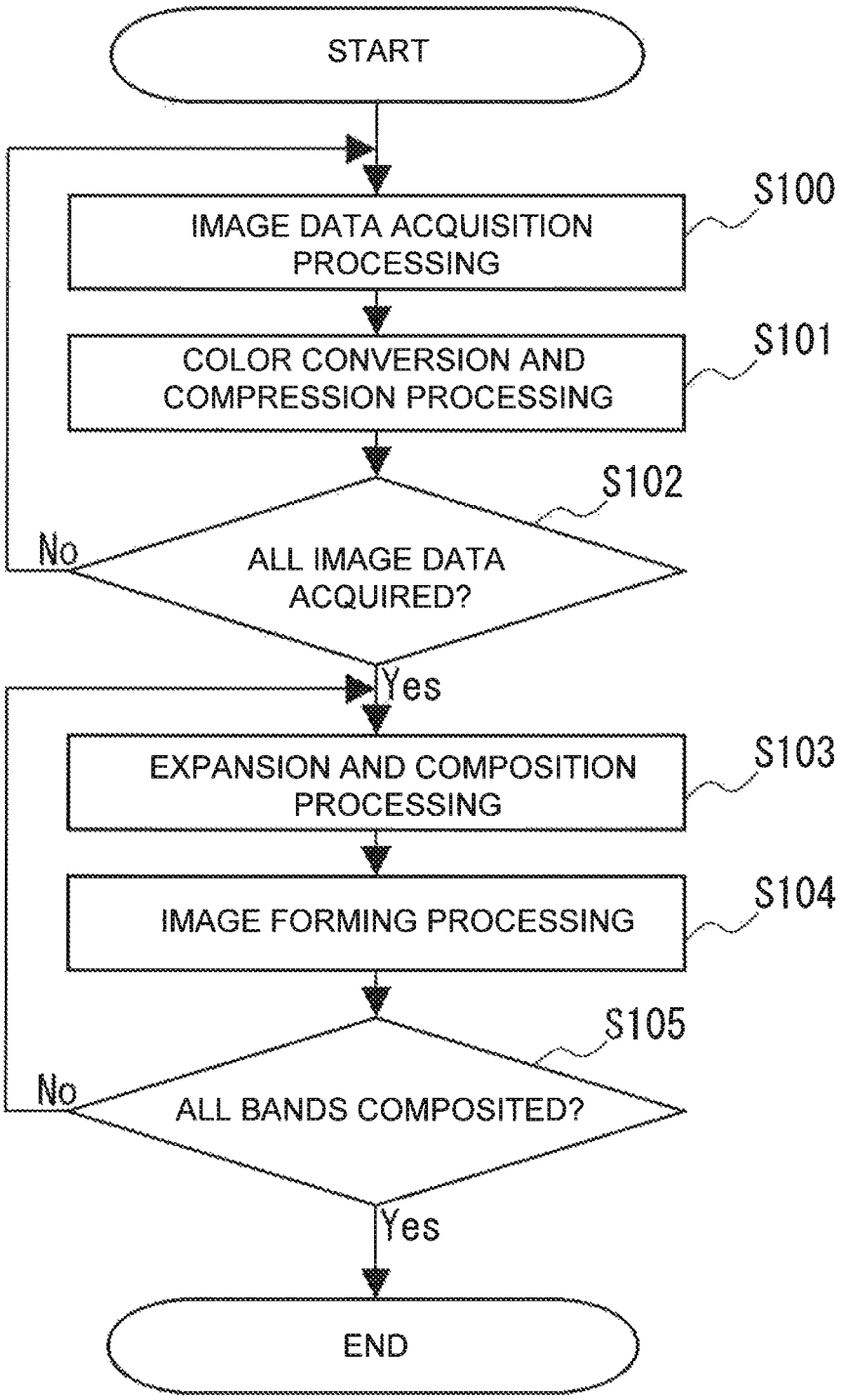

START
IMAGE DATA ACQUISITION PROCESSING
S100
COLOR CONVERSION AND COMPRESSION PROCESSING
S101
S102
No
ALL IMAGE DATA ACQUIRED?
Yes
EXPANSION AND COMPOSITION PROCESSING
S103
IMAGE FORMING PROCESSING
S104
S105
No
ALL BANDS COMPOSITED?
Yes
END

FIG.5

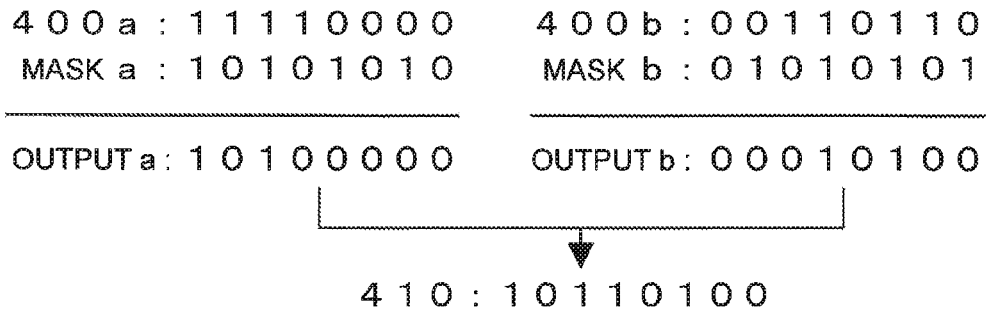

400a : 11110000
MASK a : 10101010
OUTPUT a : 10100000
400b : 00110110
MASK b : 01010101
OUTPUT b : 00010100
410 : 10110100

FIG.6
RELATED ART

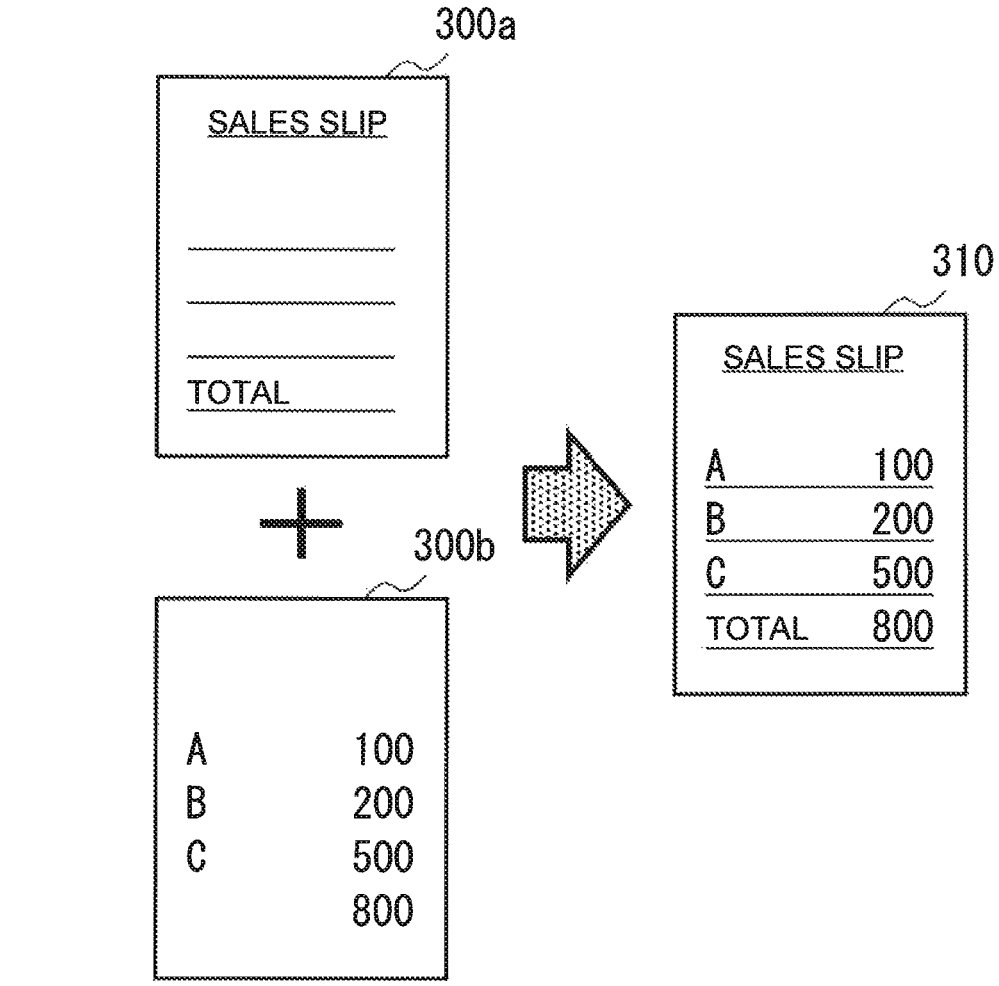


FIG.7
RELATED ART

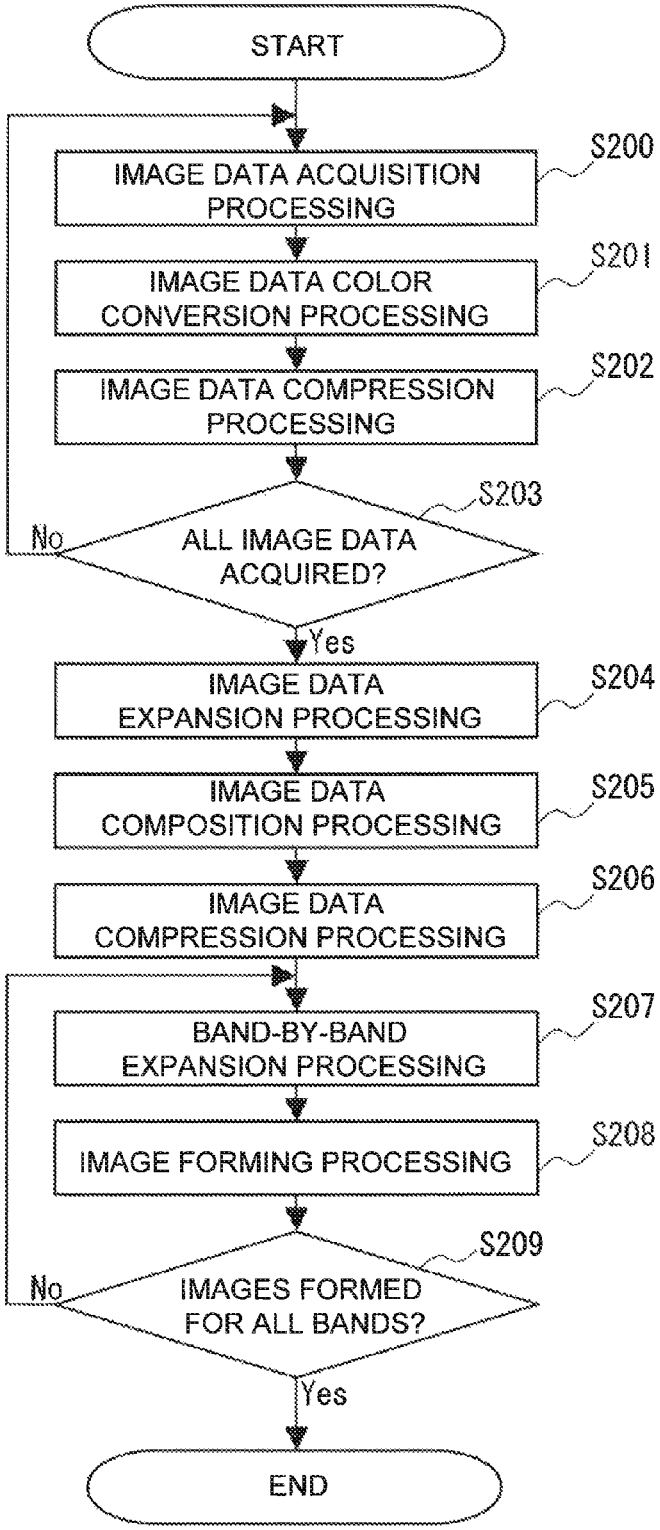


IMAGE FORMING APPARATUS, AND METHOD CAPABLE OF COMPOSITING COLOR IMAGES WITH A UNIT THAT COLOR-CONVERTS AND THEN COMPRESSES EACH OF THE PLURALITY OF PIECES OF IMAGE DATA

INCORPORATION BY REFERENCE

The disclosure of Japanese Patent Application No. 2014-62273 filed on Mar. 25, 2014 including the specification, drawings and abstract is incorporated herein by reference in its entirety.

BACKGROUND

The present disclosure relates to image forming apparatuses, image forming methods, and image forming programs, and more particularly to an image forming apparatus capable of compositing a plurality of images, and an image forming method and program performed by the apparatus.

Conventionally, there have been image forming apparatuses, such as multifunctional peripherals (MFPs) and printers, capable of printing text and images.

Some of the image forming apparatuses are able to composite a plurality of images.

FIG. **6** shows, as a typical example of image composition, the case where image data **300***a* of a form such as a sales slip and image data **300***b* of a document with actual numerical values written thereon are composited to generate image data **310** during the use of a copying function of an image forming apparatus.

For compositing images while using the copying function as described above, an image of the form is scanned first and an image of the document is scanned next, and then the two images are superposed on one another for printing them as a single image.

Typical image composition processing will be described with reference to FIG. **7**.

First, image data **300***a* of a form is acquired from a scanner (step **S200**). This form image data **300***a* is subjected to color conversion by an application-specific integrated circuit (ASIC) (step **S201**). The color-converted image data **300***a* is compressed by another ASIC, and then stored in a RAM in a storage unit (step **S202**). Next, it is determined whether all pieces of image data have been acquired. Here, it is necessary to scan a document to be composited, so the process returns to step **S200** ("No" in step **S203**). The document image data **300***b* is then acquired (step **S200**). This document image data is also subjected to color conversion by the ASIC (step **S201**). The image data **300***b* of the document image that has undergone the color conversion is also compressed (step **S202**). Next, it is determined whether all pieces of image data have been acquired. Here, the image data of the form and that of the document have both been acquired, so the process proceeds to step **S204** ("Yes" in step **S203**). Next, the form image data **300***a* and the document image data **300***b*, which are to be composited, are expanded (step **S204**). The resultant pieces of image data are composited by the ASIC on a per-image-data basis, whereby composited image data **310** is generated (step **S205**). Next, the composited image data **310** is compressed (step **S206**). Thereafter, the compressed image data **310** is expanded on a band-by-band basis (step **S207**), the "band" being a unit of data that an image forming unit can process at a time to form an image thereof. Next, on the basis of the expanded band data, an image is formed on a sheet of recording paper by the image forming unit (step **S208**). It is then determined whether images have been formed for all bands (step **S209**). If so ("Yes" in step **S209**), the process is terminated; otherwise ("No" in step **S209**), the process returns to step **S207**.

Further, an example of such an image forming apparatus capable of compositing images has been disclosed conventionally.

SUMMARY

In an aspect of the present disclosure, an image forming apparatus is capable of compositing a plurality of pieces of image data. The image forming apparatus includes a color conversion and compression unit, an expansion and composition unit, and an image forming unit. The color conversion and compression unit color-converts and then compresses each of the plurality of pieces of image data in units of band data, the band data being part of the image data. The expansion and composition unit expands and composites, in units of the band data, the plurality of pieces of image data color-converted and then compressed in units of the band data by the color conversion and compression unit. The image forming unit forms an image on the basis of the band data composited by the expansion and composition unit.

In another aspect of the present disclosure, an image forming method is performed by an image forming apparatus capable of compositing a plurality of pieces of image data. The image forming method includes the step of color-converting and then compressing each of the plurality of pieces of image data in units of band data, the band data being part of the image data. The method includes the step of expanding and compositing, in units of the band data, the plurality of pieces of image data color-converted and then compressed in units of the band data. The method includes the step of forming an image on the basis of the composited band data.

In yet another aspect of the present disclosure, an image forming program is performed by an image forming apparatus capable of compositing a plurality of pieces of image data. The image forming program causes the image forming apparatus to perform the step of color-converting and then compressing each of the plurality of pieces of image data in units of band data, the band data being part of the image data. The program causes the apparatus to perform the step of expanding and compositing, in units of the band data, the plurality of pieces of image data color-converted and then compressed in units of the band data. The program causes the apparatus to perform the step of forming an image on the basis of the composited band data.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows the functional block configuration of an image forming apparatus according to an embodiment of the present disclosure;

FIG. **2** schematically shows the configuration of the image forming apparatus;

FIG. **3** shows the control block configuration of the image forming apparatus;

FIG. **4** is a flowchart of image composition processing according to an embodiment of the present disclosure;

FIG. **5** shows the expansion and composition processing shown in FIG. **4**;

FIG. **6** shows typical image composition according to a related art; and

FIG. **7** is a flowchart of typical image composition processing.

DETAILED DESCRIPTION

The overall configuration of an image forming apparatus **1** will be described first with reference to FIG. **1**.

The image forming apparatus **1** includes an image processing unit **11**, a document reading unit **12**, a document feeding unit **13**, a transport unit (a paper feeding roller **42***b*, a pair of paper transport rollers **44**, a pair of paper ejection rollers **45**), a network transmission/reception unit **15**, an operation panel unit **16**, an image forming unit **17**, an ASIC **18**, and a storage unit **19**, which are connected to a control unit **10**. The control unit **10** controls the operations of the respective units.

The control unit **10** is an information processing unit, such as a general purpose processor (GPP), a central processing unit (CPU), a micro processing unit (MPU), a digital signal processor (DSP), a graphics processing unit (GPU), an ASIC, or the like.

The control unit **10** reads a control program stored in a read only memory (ROM) or a hard disk drive (HDD) in the storage unit **19**, deploys the program on a random access memory (RAM) and executes it, so that it operates as units in functional blocks, which will be described later. The control unit **10** also performs overall control of the apparatus in accordance with prescribed instruction information input from the operation panel unit **16** and/or from an external terminal (not shown).

The image processing unit **11** is a control arithmetic unit such as a DSP, a GPU, or the like. The image processing unit **11** performs prescribed image processing on image data **300***a*, **300***b* (FIG. **3**). The image processing includes, for example, scaling, density adjustment, gradation adjustment, and image enhancement.

The image processing unit **11** stores an image read by the document reading unit **12** in the storage unit **19** as print data. At this time, the image processing unit **11** may convert the print data into a file unit of PDF, TIFF, or other format.

The document reading unit **12** is a unit which reads (scans) a document that has been set.

The document feeding unit **13** is a unit which transports the document to be read by the document reading unit **12**.

The image forming unit **17** is a unit which is operable, in response to an output instruction by a user, to form an image on a recording sheet on the basis of the data stored in the storage unit **19**, the data read by the document reading unit **12**, or the data acquired from an external terminal.

The transport unit (the paper feeding roller **42***b*, the paper transport roller pair **44**, the paper ejection roller pair **45**) serves to transport recording paper from a paper cassette **42***a* (FIG. **2**) to the image forming unit **17** for image forming, and then transport the paper to a stack tray **50**.

The operations of the document reading unit **12**, the document feeding unit **13**, the transport unit, and the image forming unit **17** will be described later.

The network transmission/reception unit **15** is a network connection unit which includes a LAN board, a radio transceiver, and/or other component for connecting to a LAN, a wireless LAN, a WAN, a mobile telephone network, and/or other external network.

The network transmission/reception unit **15** transmits and receives data on a data communication line and voice signals on a voice telephone line.

The operation panel unit **16** includes a display unit such as an LCD, and an input unit. The input unit includes a touch panel and buttons including a numeric keypad, a start button, a cancel button, buttons for switching operating modes among copying, FAX transmission, scanning and so on, and buttons for inputting instructions on execution of jobs such as printing, transmitting, saving, and recording a selected document.

The operation panel unit **16** acquires user instructions on various jobs of the image forming apparatus **1**. Information on each user may be input or changed in accordance with a user instruction acquired through the operation panel unit **16**.

The ASIC **18** is a dedicated processing unit such as an ASIC that performs color conversion, compression, expansion, composition, rotation, etc. on image data **300** (**300***a*, **300***b*) stored in the storage unit **19**. The ASIC **18** may be configured with a low-priced and moderate-performance circuit. All that is needed for the ASIC **18** is to perform the image processing in units of band data and at a speed fast enough to prevent the image forming from being interrupted when the ASIC **18** transmits the image data **300** to the image forming unit **17**.

The ASIC **18** may additionally perform enlargement or reduction of the image data **300**. Further, the ASIC **18** may be configured with a field-programmable gate array (FPGA). Alternatively, the ASIC **18** may be an MPU, a GPU, or a DSP which has a storage unit and executes a dedicated program. Still alternatively, the ASIC **18** may be configured with two or more ASICs or the like dedicated to corresponding image processing.

The storage unit **19** is a storage unit which employs recording media including a semiconductor memory such as a ROM or a RAM, and a HDD.

The ROM or HDD of the storage unit **19** stores a control program for controlling the operations of the image forming apparatus **1**. The storage unit **19** also stores user account settings. The storage unit **19** may also include a document box area for each user.

In the image forming apparatus **1**, the control unit **10** and the image processing unit **11** may be formed unitarily, in the form of a CPU with built-in GPU, or a chip-on-module package.

Further, the control unit **10** and the image processing unit **11** may each include a RAM, a ROM, and/or a flash memory.

Still further, the image forming apparatus **1** may include a FAX transmission/reception unit that performs facsimile transmission and reception.

The operations of the image forming apparatus **1** according to the embodiment of the present disclosure will now be described with reference to FIG. **2**.

The document reading unit **12** is disposed in an upper portion of a main body unit **14**. The document feeding unit **13** is disposed above the document reading unit **12**. The stack tray **50** is arranged on the same side as a recording paper ejection port **41** formed in the main body unit **14**. The operation panel unit **16** is disposed on the front side of the image forming apparatus **1**.

The document reading unit **12** includes a scanner **12***a*, a platen glass **12***b*, and a document reading slit **12***c*. The scanner **12***a* includes an exposure lamp, a charge coupled device (CCD), a complementary metal oxide semiconductor (CMOS) imaging sensor, and so on, and is configured to be movable in the direction in which a document is transported by the document feeding unit **13**.

The platen glass **12***b* is a document table made of a transparent member such as glass. The document reading slit **12***c* has a slit formed in the direction orthogonal to the direction in which a document is transported by the document feeding unit **13**.

In the case of reading a document placed on the platen glass **12***b*, the scanner **12***a* is moved to a position facing the platen glass **12***b*, and scans and reads the document placed on the

platen glass **12***b* to acquire image data **300**. The scanner **12***a* outputs the acquired image data **300** to the control unit **10** (FIG. **1**) disposed in the main body unit **14**.

In the case of reading a document fed by the document feeding unit **13**, the scanner **12***a* is moved to a position facing the document reading slit **12***c*, and reads the document through the document reading slit **12***c* in synchronization with the document transport operation performed by the document feeding unit **13**, to acquire image data **300**. The scanner **12***a* outputs the acquired image data **300** to the control unit **10** disposed in the main body unit **14**.

The document feeding unit **13** includes a document placement unit **13***a*, a document ejection unit **13***b*, and a document transport mechanism **13***c*. The documents placed on the document placement unit **13***a* are picked up one by one and sequentially transported to the position facing the document reading slit **12***c* by the document transport mechanism **13***c*, and thereafter, they are ejected to the document ejection unit **13***b*.

The document feeding unit **13** is mounted pivotally. It can be pivotally lifted upward to uncover the upper surface of the platen glass **12***b*.

The main body unit **14** includes the image forming unit **17**, and also includes a paper feeding unit **42**, a paper transport path **43**, the paper transport roller pair **44**, and the paper ejection roller pair **45**. The paper feeding unit **42** includes a plurality of paper cassettes **42***a* each storing sheets of recording paper different in size or orientation, and the paper feeding rollers **42***b* each feeding sheets of recording paper one by one from the corresponding paper cassette **42***a* onto the paper transport path **43**. The paper feeding roller **42***b*, the paper transport roller pair **44**, and the paper ejection roller pair **45** collectively function as the transport unit. The recording paper is transported by this transport unit.

The sheet of recording paper taken out by the paper feeding roller **42***b* onto the paper transport path **43** is transported to the image forming unit **17** by the paper transport roller pair **44**. The sheet of recording paper on which an image has been recorded by the image forming unit **17** is ejected to the stack tray **50** by the paper ejection roller pair **45**.

The image forming unit **17** includes a photoconductive drum **17***a*, an exposure unit **17***b*, a developing unit **17***c*, a transfer unit **17***d*, and a fixing unit **17***e*. The exposure unit **17***b* is an optical unit including a laser device, mirrors, lenses, and an LED array. With the photoconductive drum **17***a* primarily charged by a charging unit (not shown), the exposure unit **17***b* outputs a kind of light based on the image data **300** onto the photoconductive drum **17***a* for exposure, to thereby form an electrostatic latent image on the surface of the photoconductive drum **17***a*. The developing unit **17***c* is a developing unit that develops the electrostatic latent image formed on the photoconductive drum **17***a* with toner, whereby a toner image corresponding to the electrostatic latent image is formed on the photoconductive drum **17***a*. The transfer unit **17***d* transfers the toner image formed on the photoconductive drum **17***a* by the developing unit **17***c* onto recording paper. The fixing unit **17***e* applies heat to the recording paper with the toner image transferred thereon by the transfer unit **17***d*, to thereby fix the toner image on the recording paper.

The control configuration of the image forming apparatus **1** will now be described with reference to FIG. **3**.

The control unit **10** of the image forming apparatus **1** includes an image data acquiring unit **100**.

The ASIC **18** includes a color conversion and compression unit **110** and an expansion and composition unit **120**.

The storage unit **19** stores image data **300***a*, **300***b*, and composite data **410**. Hereinafter, one of the image data **300***a*, **300***b* will be simply referred to as image data **300**. As for bands **400***a* and **400***b* included in the respective image data **300**, one of the bands will be simply referred to as a band **400**.

The image data acquiring unit **100** acquires image data **300** from the document reading unit **12**, or from an external terminal or a recording medium (not shown), and stores the acquired image data in the storage unit **19**.

The image data acquiring unit **100** may also analyze the page description language (PDL) of document data and draw it for conversion into image data **300**.

The color conversion and compression unit **110** performs color conversion and then compression on each of a plurality of pieces of image data **300**.

For example, the color conversion and compression unit **110** uses a look up table (LUT) to convert color image data **300** with 8 bits or 16 bits each for red, green, and blue (RGB), into color image data **300** with 8 bits each for cyan, magenta, yellow, and black (CMYK).

Further, the color conversion and compression unit **110** compresses the color-converted image data **300** in a prescribed format such as run-length encoding, Huffman coding, or JBIG. The compressed data can be expanded in units of data of bands **400** by the expansion and composition unit **120**, which will be described below.

The expansion and composition unit **120** expands and composites the plurality of pieces of image data **300** color-converted and compressed by the color conversion and compression unit **110**. At this time, the expansion and composition unit **120** expands and composites the data in units of data of bands **400**, the band being part of the data.

As for the overlapping bits of the pieces of expanded image data **300**, the expansion and composition unit **120** averages those bits by the number of pieces of image data **300** before composition. At this time, for example, the expansion and composition unit **120** may first binarize each image data **300** by dithering the images of the respective colors of C, M, Y, and K to generate binarized bands **400**, and then composite the binarized bands **400** by using bit masks corresponding respectively thereto.

Further, the expansion and composition unit **120** causes the image forming unit **17** to form an image on the basis of composite data **410** which is the composited band data.

Image data **300** is data of images to be composited. The image data **300** may be, for example, image data **300** read by the document reading unit **12**, print data acquired from another terminal or the like, or image data **300** bitmapped by rasterizing PDL.

The image data **300** may be of RGB colors or of CMYK colors. The number of bits for each color of the image data **300** is arbitrary. The image data **300** may be raw bitmap data, or may have been compressed in a prescribed format.

The number of pieces of image data **300** is not limited to two; two or more pieces of image data **300** can be composited.

Image data **300** includes bands **400** which are band data.

A band **400** is part of image data **300**. The band **400** may be bitmap data of each color having a size (capacity) that the image forming unit **17** is capable of forming an image thereof at a time. The band **400** may also be raw, or may have been compressed in a prescribed format.

Composite data **410** is data obtained by compositing a plurality of bands **400**. The composite data **410** is data in a unit of band data, corresponding to the band **400**.

The composite data **410** may be raw bitmap data, as is the band **400**. The composite data **410** may have the same size as the band **400**.

The control unit **10** of the image forming apparatus **1** is caused to function as the image data acquiring unit **100** as the unit **10** executes the control program stored in the storage unit **19**.

Further, the above-described units in the image forming apparatus **1** become hardware resources that carry out the image forming method of the present disclosure.

Image composition processing performed by the image forming apparatus **1** according to an embodiment of the present disclosure will now be described with reference to FIGS. **4** and **5**.

In the image composition processing of the present embodiment, image data **300***a*, **300***b* are acquired, and color-converted and compressed. The compressed image data **300***a*, **300***b* are expanded and composited in units of data of bands **400***a*, **400***b*, so that composite data **410** is generated. Thereafter, an image is formed on the basis of the composite data **410**.

To carry out the image composition processing of the present embodiment, the control unit **10** executes a program stored in the storage unit **19** and uses the hardware resources to carry out the processing in cooperation with the ASIC **18** and other units.

Details of the image composition processing of the present embodiment will now be described step by step with reference to the flowchart in FIG. **4**.

<Step S**100**>

First, the control unit **10** functions as the image data acquiring unit **100** to perform image data acquisition processing.

The control unit **10** may cause the document reading unit **12** to read a document set on the document feeding unit **13** to acquire the image as the image data **300**.

Alternatively, the control unit **10** may acquire the image data **300** already existing in a user storage folder in the storage unit **19** or in a connected recording medium.

Still alternatively, the control unit **10** may acquire the image data **300** from a storage folder in another terminal or server through a network, or may acquire image data received by facsimile as the image data **300**.

The control unit **10** stores the acquired image data **300** in the storage unit **19**. At this time, the control unit **10** may convert the image data **300** into bitmap data or the like.

<Step S**101**>

Next, the color conversion and compression unit **110** performs color conversion and compression processing.

The control unit **10** performs color conversion on the acquired image data **300**, and then compresses the resultant data.

For example, the control unit **10** reads the image data **300** from the storage unit **19** in units of band data, and uses a LUT or the like to perform color conversion from RGB colors to CMYK colors. The control unit **10** compresses the converted bands **400** in a prescribed format, and then replaces the data of the bands **400** before the color conversion in the image data **300** with the color-converted and compressed data.

With this configuration, it becomes unnecessary to prepare a work memory for the entire image data **300** at a time, and it is thus possible to reduce the capacity of the work memory required for the color conversion and compression.

<Step S**102**>

Next, the control unit **10**, functioning as the image data acquiring unit **100**, determines whether it has acquired all pieces of image data **300**. If all the pieces of image data **300** have been acquired, the control unit **10** determines "Yes"; otherwise, the control unit **10** determines "No".

If the control unit **10** determines "No", the process returns to step S**100**.

If the control unit **10** determines "Yes", the process proceeds to step S**103**.

<Step S**103**>

After all the pieces of image data **300** have been acquired, the expansion and composition unit **120** performs expansion and composition processing.

The expansion and composition unit **120** expands the bands **400** in the pieces of image data **300** color-converted and compressed by the color conversion and compression unit **110**, and composites the resultant bands. At this time, for example, the expansion and composition unit **120** averages the bits in the data of the expanded bands **400** by the number of pieces of the image data **300** before composition.

This processing will be described more specifically with reference to FIG. **5**. For example, the expansion and composition unit **120** reads bands **400** located in the same positions in the respective pieces of image data **300** to be composited. The expansion and composition unit **120** then expands the read bands and converts them into bitmap data before compositing them. At this time, for example, the expansion and composition unit **120** generates bitmap data by binarizing color data of the respective colors by dithering. The expansion and composition unit **120** then ANDs the bitmap data with bit masks for the respective bands **400**. The expansion and composition unit **120** can average the bits by ORing those outputs, for example. In the example in FIG. **5**, a mask a for the band **400***a* and a mask b for the band **400***b*, which are the one's complement of each other, are prepared and used to obtain outputs a and b. These outputs a and b are then ORed to obtain composite data **410**.

With this configuration, quantization errors can be reduced, and the image data **300** after the composition can be improved in appearance. Such reduction in errors is noticeable particularly in the case of compositing image data **300** which is binary in nature, such as data received by facsimile, with image data **300** of a plurality of colors. This means that, even when those images are composited, the text included in the facsimile image is easy to read.

<Step S**104**>

Next, the image forming unit **17** performs image forming processing.

The image forming unit **17** forms an image on a sheet of recording paper on the basis of the composite data **410**.

At this time, the image of the composite data **410** can be formed in the same manner as that of an ordinary band **400**.

It may be configured to cause the control unit **10** to delete the composite data **410** after the image has been formed.

<Step S**105**>

Next, the expansion and composition unit **120** determines whether all bands **400** have been composited. If all the bands **400** in the pieces of image data **300** have been composited and output, the expansion and composition unit **120** determines "Yes"; otherwise, it determines "No".

If the expansion and composition unit **120** determines "Yes", the image composition processing is terminated.

If the expansion and composition unit **120** determines "No", the process returns to step S**103**, where other bands **400** are composited. In the case where there is more than one page, the similar processing can be performed on a per-page basis.

In the above-described manner, the image composition processing according to the embodiment of the present disclosure is completed.

The above configurations can provide the following effects.

In a conventional image forming apparatus, for compositing images, pieces of acquired image data **300** were compressed and expanded one by one, and then composited and

output on a per-image basis. This involved futile processing and required a large-capacity work memory.

In contrast, the image forming apparatus **1** according to the embodiment of the present disclosure is capable of compositing a plurality of pieces of image data **300** and includes: the color conversion and compression unit **110** that color-converts and then compresses each of the plurality of pieces of image data **300** in units of data of bands **400**, the band being part of the image data **300**; the expansion and composition unit **120** that expands and composites, in units of data of the bands **400**, the plurality of pieces of image data **300** color-converted and then compressed by the color conversion and compression unit **110**; and the image forming unit **17** that forms an image on the basis of composite data **410** which is the data of the bands **400** composited by the expansion and composition unit **120**.

With this configuration, as compared to the conventional image forming apparatus, it is possible to reduce unproductive processing and save the usage of the work memory. It becomes unnecessary to prepare ASICs dedicated to different processing, and it is possible to save the storage capacity of the storage unit **19** and reduce the cost. It is also possible to improve the performance during the image composition processing.

The composited image data **300** is not stored on a per-image basis. This makes hacking (e.g., extracting composite data **410** from the storage unit **19**) difficult, so security can be ensured.

Further, in the image forming apparatus **1** according to the embodiment of the present disclosure, the expansion and composition unit **120** performs the composition after averaging overlapping bits in the respective pieces of the expanded image data **300** by the number of pieces of the image data **300**.

With this configuration, the ASIC **18** for data compression and expansion, the throughput of which is not so high, can be used to perform the composition processing, leading to reduced cost.

In the embodiment of the present disclosure, two pieces of image data **300***a* and **300***b* were composited. However, it is also possible to composite two or more pieces of image data **300**.

In such a configuration, in the case of averaging the bits in the same manner as in the above-described expansion and composition processing, a mask of a value that, when ORed, yields "−1" in two's complement, i.e. "0xFF" in hexadecimal notation ("11111111b" in binary notation) in the case of eight bits, may be prepared for each of the two or more pieces of image data **300**.

With this configuration, a plurality of pieces of image data **300** can be composited rapidly and efficiently, leading to reduced cost.

Further, in the above embodiment, for simplification of explanation, it was assumed that only two kinds of masks were prepared. However, different masks may be used depending on, for example, the line positions of the bands **400**. For example, it may be configured such that masks a and b are used for the bands **400***a* and **400***b*, respectively, in even-numbered lines, and such that the masks b and a are used for the bands **400***a* and **400***b*, respectively, in odd-numbered lines. Further, a mask of a pattern having a prescribed size may be prepared. In this case, the use of a mask having the size of a power of two, such as 128 bits×128 bits, for example, enables high-speed processing.

With this configuration, it is possible to suppress the occurrence of moire caused by composition of bits and, thus, to improve the display quality.

Further, in the above embodiment, the bits were averaged for each color after application of dithering.

Alternatively, the expansion and composition unit **120** may be configured to average the bits for each gradation level for each color before application of dithering. For example, in the case where each color is of 8-bit gradation, the expansion and composition unit **120** may OR the bits of each color and then shift the bits by one to the right for averaging. Still alternatively, the expansion and composition unit **120** may compress the gradation levels before image forming. For example, for each image data **300**, the expansion and composition unit **120** may acquire the upper four bits out of the eight bits for each color and OR them, and then shift the bits by one to the right to thereby obtain composite data **410** of 4-bit gradation. Thereafter, the expansion and composition unit **120** may expand the data into eight bits through gradation correction at the time of image forming.

With this configuration, the processing load on the ASIC can be reduced, enabling high-speed image forming.

Further, in the above embodiment, the image composition was carried out in the ASIC **18**. Alternatively, the similar processing may be carried out in the image processing unit **11**, or some of the processing may be carried out in the control unit **10**. In this case, accelerating processing by the GPU or the like of the control unit **10** may be performed.

The present disclosure is also applicable to information processing apparatuses other than the image forming apparatuses. Specifically, it is applicable to the configuration which uses, for example, a server to which a network scanner or a scanner is connected via a USB or the like. Further, the present disclosure is also applicable to the configuration in which, after the composition of the acquired image data **300**, the resultant data is converted to a file or the like, without being subjected to image forming.

It should be noted that the configurations and operations in the above embodiment are merely illustrative; they may be appropriately modified for implementation without departing from the scope of the present disclosure.

What is claimed is:

1. An image forming apparatus capable of compositing a plurality of pieces of image data, the apparatus comprising:

a storage unit;

a color conversion and compression unit that reads the plurality of pieces of image data from the storage unit in units of band data, color-converts each of the plurality of pieces of image data in units of the band data using a LUT from RGB colors to CMYK colors, and then compresses each of the plurality of pieces of image data in units of the band data, the band data being part of the image data;

an image data acquiring unit that determines whether all the plurality of pieces of image data have been acquired,

an expansion and composition unit that expands and composites, in units of the band data, the plurality of pieces of image data color-converted and then compressed in units of the band data by the color conversion and compression unit, if all the plurality of pieces of image data have been acquired; and

an image forming unit that forms an image on the basis of the band data composited by the expansion and composition unit,

wherein the expansion and composition unit performs the composition after averaging overlapping bits in the respective pieces of the expanded image data by the number of pieces of the image data,

wherein the expansion and composition unit reads the band data located in the same positions in the respective

pieces of image data to be composited, then expands the read band data, and converts them into bitmap data before compositing them, and

wherein the expansion and composition unit generates bitmap data by binarizing color data of the respective colors by dithering, then ANDs the bitmap data with bit masks for the respective band data, and averages the bits by ORing output of the bitmap data with the bit masks.

2. An image forming method performed by an image forming apparatus including a storage unit capable of compositing a plurality of pieces of image data, the method comprising:

reading the plurality of pieces of image data from the storage unit in units of band data;

color-converting each of the plurality of pieces of image data in units of the band data using a LUT from RGB colors to CMYK colors;

compressing each of the plurality of pieces of image data in units of the band data, the band data being part of the image data;

determining whether all the plurality of pieces of image data have been acquired;

expanding and compositing, in units of the band data, the plurality of pieces of image data color-converted and then compressed in units of the band data, if all the plurality of pieces of image data have been acquired; and

forming an image on the basis of the composited band data,

wherein the expanding and compositing includes performing the composition after averaging overlapping bits in the respective pieces of the expanded image data by the number of pieces of the image data,

wherein the expanding and compositing includes reading the band data located in the same positions in the respective pieces of image data to be composited, then expanding the read band data, converting them into bitmap data before compositing them, and

wherein the expanding and compositing includes generating bitmap data by binarizing color data of the respective colors by dithering, then ANDing the bitmap data with bit masks for the respective band data, and averaging the bits by ORing output of the bitmap data with the bit masks.

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